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(54) Title: SUBSTITUTED DIHYDROBENZOFURAN DERIVATIVES AS 5-HT ₄ AGONISTS (57) Abstract The present invention relates to the use of substituted dihydrobenzofuran derivatives having 5-HT ₄ receptor agonist activity, which act as therapeutic prokinetic agents in treatment of gastrointestinal disorders such as, e.g., dyspepsia, gastro-oesophageal reflux disease (GORD) or gastroparesis. The compounds of the invention can also be useful in the treatment of CNS disorders, characterized by learning and/or memory dysfunctions. Several of these substituted dihydrobenzofuran derivatives are novel compounds and, as such, constitute a further object of the invention, together with the process for their preparation and the pharmaceutical compositions containing them.		

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SUBSTITUTED DIHYDROBENZOFURAN DERIVATIVES AS 5-HT₄ AGONISTS

The present invention relates to the use of substituted dihydrobenzofuran derivatives which act as 5-HT₄ receptor agonists in the treatment of gastrointestinal disorders and CNS disorders, to certain novel compounds having 5-HT₄ receptor agonist activity, to a process for their preparation and to pharmaceutical compositions containing them.

10 A non classical 5-hydroxytryptamine receptor has been designed (Trends Pharmacol. Sci. (1992) 13, 141-5) as the 5-HT₄ receptor.

The prokinetic action of the substituted benzamide metoclopramide, which has long been in clinical use as a stimulant of gastrointestinal motility, is believed to be on the basis of its agonist effect on the 5-HT₄ receptor (Drug Design & Delivery (1988) 3, 273-295).

Some 5-HT₄ receptor agonists resulted active in appropriate animal behavioural tests for memory dysfunctions (Ghelardini et al. 19th C.I.N.P. Congress, Whashington, June 1994 ; Ghelardini et al. 10th European Society for Neurochemistry, Jerusalem, August 1994).

International patent application WO 93/16072 describes 5-

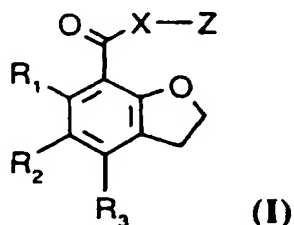
HT₄ receptor antagonists derived from the benzopyran, benzothiopyran or benzofuran nucleus.

International patent application WO 94/08995 relates to novel carboxylate or carboxamides of benzofuran or
5 dibenzofuran having 5-HT₄ antagonist activity.

We have identified a class of substituted dihydrobenzofuran carboxylic acid derivatives which possess 5-HT₄ receptor agonist properties, despite their structural analogies with the closest prior art compounds such as, e.g., those
10 disclosed in WO 93/16072 and WO 94/08995 having 5-HT₄ antagonist activity.

By virtue of their 5-HT₄ agonist activity, the compounds of the invention can be useful in all the pathologies wherein a stimulation of the 5-HT₄ receptors is needed and
15 therefore, the compounds of the invention can be useful, for example, as therapeutic prokinetic agents in the treatment of gastrointestinal disorders such as, e.g., dyspepsia, gastro-oesophageal reflux disease (GORD) and gastroparesis, and/or also in the treatment of CNS
20 disorders characterized by learning and/or memory dysfunctions.

Accordingly, the present invention relates to dihydrobenzofuran derivatives of formula (I)

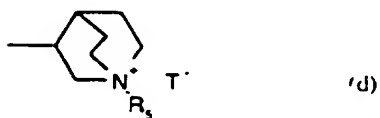
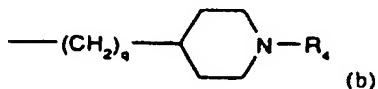
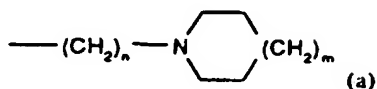


wherein

R_1 , R_2 and R_3 are, each independently, hydrogen, C_1 - C_6 alkyl, halogen, hydroxy, C_1 - C_4 alkoxy, amino, C_1 - C_4 alkylamino or C_1 - C_4 di-alkylamino;

5 X is O, NH or CH_2 ;

Z is a group (a), (b), (c) or (d)



wherein

n is 1, 2, 3 or 4;

m is zero or 1;

10 q is zero, 1 or 2;

R_4 is hydrogen, C_1 - C_6 alkyl, benzyl, cyclohexylmethyl or

-CH₂-CH₂-SO₂NH-R₆ in which R₆ is C₁-C₆ alkyl or benzyl;

R₅ is C₁-C₆ alkyl; and

T is halogen;

provided that, when Z is defined under (c), then X is O or

5 CH₂, and their pharmaceutically acceptable salts, for use
as 5-HT₄ agonists. The compounds of formula (I) can
therefore be useful in the treatment of all the pathologies
wherein a stimulation of the 5-HT₄ receptor is needed. As
an example, the compounds of formula (I) may be useful as
10 therapeutic prokinetic agents in the treatment of
gastrointestinal disorders such as, for example, dyspepsia,
gastro-oesophageal reflux disease (GORD) or gastroparesis.
The compounds of formula (I) may also be useful, by virtue
of their 5-HT₄ agonist properties, as cognition activators,
15 in the treatment of CNS disorders characterized by learning
and/or memory dysfunctions.

The alkyl, alkoxy and alkylamino groups may be branched or
straight groups.

Representative examples of C₁-C₆ alkyl groups include
20 methyl, ethyl, *n*- and *iso*-propyl, *n*-, *iso*-, *sec*- and *tert*-
butyl.

Representative examples of C₁-C₄ alkoxy groups include
methoxy and ethoxy.

A C₁-C₄ alkylamino group is, in particular, methylamino or
25 ethylamino.

A C₁-C₄ di-alkylamino group is, in particular, dimethylamino or diethylamino.

Halogen includes fluorine, bromine, chlorine or iodine, in particular, chlorine or bromine.

- 5 The pharmaceutically acceptable salts of the compounds of formula (I) include acid addition salts with inorganic, e.g. hydrochloric, hydrobromic, sulphuric, and phosphoric acids, or organic, e.g. acetic, propionic, lactic, oxalic, malic, maleic, tartaric, citric, benzoic, mandelic,
10 salicylic and fumaric acids.

- Examples of pharmaceutically acceptable salts of the compounds of formula (I) wherein Z is a group (a) or (b) include quaternary derivatives such as, e.g., the compounds quaternised by compounds of formula R_x-W wherein
15 R_x is C₁-C₆ alkyl or phenyl-C₁-C₆alkyl and W is a radical corresponding to an anion of an acid.

Preferably, R_x is C₁-C₄ alkyl or phenyl-C₁-C₄alkyl, in particular it is methyl, ethyl, n-propyl, n-butyl, benzyl or phenylethyl.

- 20 Preferably, W is a halide such as, e.g., chloride, bromide or iodide.

Examples of pharmaceutically acceptable salts of the compounds of formula (I) wherein Z is a group (a), (b) or (c) also include internal salts, such as, e.g. N-oxides.

- 25 The compounds of formula (I), their pharmaceutically

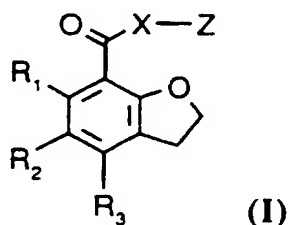
acceptable salts, (including quaternary derivatives and N-oxides) may also form pharmaceutically acceptable solvates, such as hydrates, which are also object of the present invention.

5 Compounds of formula (I) wherein Z is a group (c) contain an asymmetric carbon atom and, for this reason, they can exist either as a mixture of optical isomers (racemic mixture) or as a single optical isomers (enantiomers). The enantiomers can be separately synthesised from optically
10 pure starting material or separated from the racemic mixture in a conventional manner.

The present invention also include within its scope both the metabolites and the pharmaceutically acceptable bioprecursors (otherwise known as pro-drugs) of the compounds
15 of formula (I).

This invention also refers to a preferred class of compounds within formula (I), as novel compounds.

These compounds, which form a further object of the invention, are compounds of formula (I)



wherein

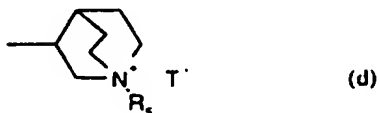
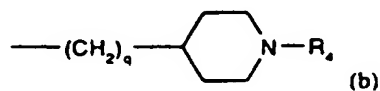
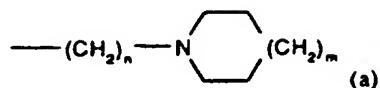
R₁ is hydrogen;

R₂ is chlorine or bromine;

R_3 is amino;

X is O or NH;

Z is a group (a), (b), (c) or (d):



wherein

5 n is 2 or 3;

m is zero or 1;

q is 1 or 2;

R_4 is $\text{C}_3\text{--C}_5$ alkyl or $\text{---CH}_2\text{---CH}_2\text{---SO}_2\text{NH---CH}_3$;

R_5 is $\text{C}_3\text{--C}_5$ alkyl; and

10 T is chlorine or bromine;

provided that, when Z is defined under (c), then X is O;

and their pharmaceutically acceptable salts.

Examples of preferred compounds according to the invention are the following:

N-[1-butyl-1-azabicyclo[2,2,2]oct-3-yl]-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxamide bromide;

(1-azabicyclo[2,2,2]oct-3-yl)-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxylate;

5 (1-butyl-piperid-4-yl)methyl-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxylate;

(1-piperidyl)propyl-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxylate;

10 (1-piperidyl)ethyl-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxylate;

N-[(1-butyl-piperid-4-yl)methyl]-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxamide;

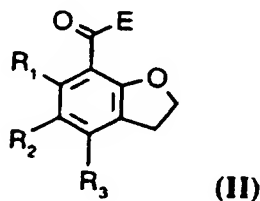
N-[(1-piperidyl)propyl]-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxamide; and

15 N-[(1-piperidyl)ethyl]-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxamide;

if the case either as a single isomer or as a mixture of isomers thereof, and the pharmaceutically acceptable salts thereof.

20 The compounds of formula (I) can be obtained by a process comprising:

A) reacting a compound of formula (II)



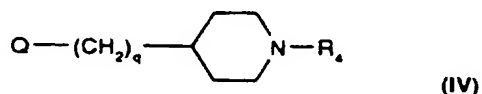
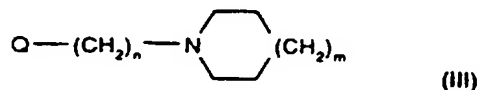
wherein

E is OH, Cl, Br or 1-imidazolyl, and

R₁, R₂ and R₃ are, each independently, hydrogen, C₁-C₆ alkyl, halogen, hydroxy, C₁-C₄ alkoxy, amino, C₁-C₄ alkylamino or

5 C₁-C₄ di-alkylamino,

with an amine or an alcohol of formula (III), (IV) or (V)



wherein

Q is OH or NH₂;

n is 1, 2, 3 or 4;

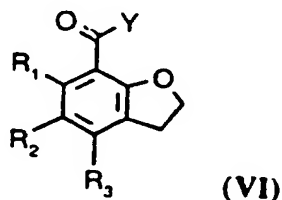
10 m is 0 or 1;

q is 0, 1 or 2; and

R₄ is hydrogen, C₁-C₆ alkyl, benzyl, cyclohexylmethyl or -CH₂-CH₂-SO₂-NH-R₆ in which R₆ is C₁-C₆ alkyl or benzyl

so obtaining a compound of formula (I) wherein R₁, R₂, R₃ and R₆ are as defined above, X is NH or O and Z is a group (a), (b) or (c); or

B) reacting a compound of formula (VI)



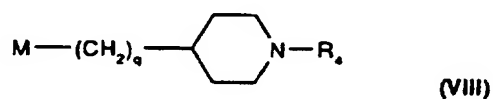
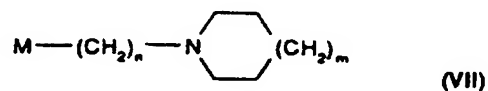
wherein

Y is OH, Cl, Br or CH₃-NH-OCH₃, and

R₁, R₂ and R₃ are as defined above,

with an organometallic derivative of formula (VII), (VIII)

5 or (IX)



wherein

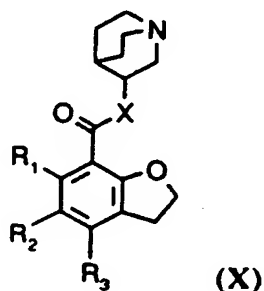
M is MgBr, MgCl or Li, and

n, m, q, R₄ and R₅ are as defined above,

so obtaining a compound of formula (I) wherein R₁, R₂ and

10 R₃ are as defined above, X is CH₂ and Z is a group (a), (b) or (c); or

C) reacting a compound of formula (X)



wherein R₁, R₂, R₃ and X are as defined above, and

X is NH, O or CH₂,

- with an alkyl halide of formula R_5T wherein R_5 is C_1-C_6 alkyl and T is halogen, so obtaining a compound of formula (I) wherein R_1 , R_2 , R_3 are as defined above, X is O, NH, or CH_2 and Z is a group (d) ; and, if desired, when a compound
- 5 of formula (I) contains an asymmetric carbon atom,
- D) resolving the racemic mixture of a compound of formula (I) into the single isomers; and/or, if desired,
- E) converting a compound of formula (I) into a pharmaceutically acceptable salt thereof.
- 10 The reaction of a compound of formula (II) with a compound of formula (III), (IV) or (V) under step A) is an analogy process and can be carried out according to well known methods in the art. For instance, an acyl halide of formula (II) can be reacted with an alcohol or an amine of formula
- 15 (III), (IV) or (V) in a suitable organic solvent such as, for instance, dichloromethane, tetrahydrofuran or acetonitrile, at a temperature ranging from about $0^\circ C$ to about the reflux temperature of the mixture, in the presence of a proton scavenger such as, for instance,
- 20 triethylamine, sodium hydrogen carbonate or potassium carbonate.
- The reaction of a compound of formula (VI) with a compound of formula (VII), (VIII) or (IX) under step B) can also be carried out according to well known methods in the art. For
- 25 instance, an acyl halide of formula (VI) can be reacted

with a Grignard reactive of formula (VII), (VIII) or (IX) in a suitable organic solvent such as, e.g., tetrahydrofuran or diethyl ether in the presence of, e.g., Fe(acetylacetonate)₃ or CuI, at a temperature ranging from
5 about -78°C to about 30°C.

The reaction of a compound of formula (X) with an alkyl halide R₅T under step C) can be carried out according to standard methodologies. For instance, a compound of formula (X) can be reacted with a compound R₅T as defined above, in
10 the presence of a suitable organic solvent such as, e.g., methanol or ethanol, at a temperature ranging from about 30°C to about the reflux temperature of the mixture.

The carboxylic acids of formulae (II) and (VI) wherein E and Y are OH are either commercially available or known
15 products.

The acid derivatives (II) and (VI) are either known products (EP 0 234 872 A1 Adria Laboratories Inc.) or may be prepared from the corresponding acids by methods well known in the art.

20 The alcohols and amines of formulae (III), (IV) and (V) are either commercially available or known products.

The organometallic derivatives of formulae (VII), (VIII) and (IX) can be prepared by standard methodologies from the corresponding alkyl halides which are either commercially
25 available products or can be easily prepared from the

corresponding alcohols of formulae (III), (IV) and (V). The compounds of formula (X) wherein X is NH are known compounds (EP 0 234 872 A1 Adria Laboratories Inc.).

The alkyl halides of formula R_5T are commercially available products.

The separation of a mixture of isomers of a compound of the invention into single isomers and the conversion of a compound of formula (I) into a pharmaceutically acceptable salt thereof can be carried out according to well known methods in the art.

As already said, the compounds of the present invention are potent agonists of 5-HT (serotonin) on 5-HT₄ receptors and can therefore be used in the treatment of the pathologies wherein a stimulation of the 5-HT₄ receptor is needed. In particular, as 5-HT₄ agonists are known being stimulant of gastrointestinal motility, the compounds of the present invention can be useful as therapeutic prokinetic agents, for example, in the treatment of gastrointestinal disease such as, for instance, dyspepsia, gastro-oesophageal reflux disease (GORD) or gastroparesis. In addition, in view of the fact that 5-HT₄ receptors are believed to be involved in synaptic plasticity events and in memory processes (CNS Drugs (1994) 1, 6-15), and that it has been demonstrated that 5-HT₄ receptor stimulation facilitates in vivo acetylcholine release in rat frontal cortex (NeuroReport

(1994) 5, 1230-2), another application of the compounds of the invention may also be as cognition activators in the treatment of CNS disorders characterized by learning and/or memory dysfunctions.

5 5-HT₄ receptor affinity of the compounds of the present invention was determined by the inhibition of the binding of the 5-HT₄ receptor radioligand [³H]-GR-113808 in rat striatum, according to the method of Grossman et al. (Br.J.Pharmacol., 1993, 109, 618-624).

10 The activity of the compounds of the present invention as 5-HT₄ agonists was evaluated "in vitro" by the receptor-mediated relaxation responses of rat, carbachol precontracted oesophageal muscularis mucosae, following the method of Baxter et al., (Naunhyn Schmiedeberg's Arch.
15 Pharmacol., 1991, 343, 439-446).

As an example, a representative group of compounds according to this invention, namely

(S) - (+) - N - [1-butyl-1-azabicyclo[2,2,2]oct-3-yl] - 4-amino-
5-chloro-2,3-dihydrobenzo[b]furan-7-carboxamide bromide
20 monohydrate (internal code FCE 28773A);
(1-butyl-piperid-4-yl)methyl-4-amino-5-chloro-2,3-
dihydrobenzo[b]furan-7-carboxylate hydrochloride
(internal code FCE 29029A);
N - [(1-butyl-piperid-4-yl)methyl] - 4-amino-5-chloro-2,3-
25 dihydrobenzo[b]furan-7-carboxamide hydrochloride

- (internal code FCE 29030A);
- (1-piperidyl)ethyl-4-amino-5-chloro-2,3-dihydrobenzo[b]
furan-7-carboxylate hydrochloride hemihydrate (internal
code FCE 29032A);
- 5 N-[(1-piperidyl)ethyl]-4-amino-5-chloro-2,3-dihydrobenzo
[b]furan-7-carboxamide hydrochloride hydrate (internal
code FCE 29033A);
- (1-piperidyl)propyl-4-amino-5-chloro-2,3-
dihydrobenzo[b]furan-7-carboxylate hydrochloride
10 hemihydrate (internal code FCE 29031A);
- N-[(1-piperidyl)propyl]-4-amino-5-chloro-2,3-
dihydrobenzo[b]furan-7-carboxamide hydrochloride hydrate
(internal code FCE 29034A) and
- (S)-(+)-(1-azabicyclo[2,2,2]oct-3-yl)-4-amino-5-chloro-
15 2,3-dihydrobenzo[b]furan-7-carboxylate hydrochloride
(internal code FCE 28797A);

were tested according to the methods described above and
the obtained results are reported on Table 1.

Table 1

20

Compound	Binding assay K_i (nM)	5-HT ₄ R activity EC_{50} (nM)
FCE 28773A	1.9	8.5 (i.a.=0.52)
FCE 29029A	0.13	5.67 (i.a.=1.0)
FCE 29030A	1.9	4.49 (i.a.=0.59)

FCE 29032A	0.94	2.02 (i.a.=0.71)
FCE 29033A	41	35.4 (i.a.=0.65)
FCE 29031A	4.5	7.43 (i.a.=0.70)
FCE 29034A	9.6	19.3 (i.a.=0.60)
FCE 28797A	8.3	11.1 (i.a.=0.71)

$$K_i = \frac{IC_{50}}{1 + \frac{[L]}{K_d}}$$

10 where

IC_{50} = concentration of the tested compound which forces the displacements of 50% of the bound radioligand concentration, obtained in the absence of inhibitor.

$[L]$ = radioligand concentration

15 K_d = dissociation constant of the radioligand-receptor complex.

EC_{50} = efficacy concentration: concentration of the tested compound which induces 50% of the max. response (in this case 50% of the max. relaxation).

20 i.a. = intrinsic activity: max. response/max response of the natural agonist (in this case max. relaxation/5-HT max.relaxation).

The tabulated results clearly show that the compounds of the invention exhibit high affinity for the 5-HT₁ receptor sites and, in the same time, are particularly effective in

25

promoting 5-HT₄ receptor activity.

The compounds of the invention can be administered in a variety of dosage forms, e.g. orally, in the form of tablets, capsules, sugar or film coated tablets, liquid
5 solutions or suspensions; rectally in the form of suppositories; parenterally, e.g. intramuscularly, or by intravenous injection or infusion.

The dosage depends on the age, weight, conditions of the patient and on the administration route; for example, the
10 dosage adopted for oral administration to adult humans e.g. for the representative compound of the invention FCE 29034A may range from about 1 to about 500 mg pro dose, from 1 to 5 times daily.

The invention includes pharmaceutical compositions
15 comprising a compound of the invention as an active principle in association with a pharmaceutically acceptable excipient (which can be a carrier or a diluent).

The pharmaceutical compositions containing the compounds of the invention are usually prepared following conventional
20 methods and are administered in a pharmaceutically suitable form.

For example, the solid oral forms may contain, together with the active compound, diluents, e.g. lactose, destrose, saccharose, cellulose, corn starch or potato starch;
25 lubricants, e.g. silica, talc, stearic acid, magnesium or

calcium stearate, and/or polyethylene glycols; binding agents, e.g. starches, arabic gums, gelatin, methylcellulose, carboxymethylcellulose or polyvinyl pyrrolidone; disaggregating agents, e.g. a starch, alginic acid, alginates or sodium starch glycolate; effervescing mixtures; dyestuffs; sweeteners; wetting agents such as lecithin, polysorbates, laurylsulphates; and, in general, non-toxic and pharmacologically inactive substances used in pharmaceutical formulations. Said pharmaceutical preparations may be manufactured in known manner, for example, by means of mixing, granulating, tableting, sugar-coating, or film-coating processes.

The liquid dispersion for oral administration may be e.g. syrups, emulsions and suspension.

The syrups may contain as carrier, for example, saccharose or saccharose with glycerine and/or mannitol and/or sorbitol.

The suspensions and the emulsions may contain as carrier, for example, a natural gum, agar, sodium alginate, pectin, methylcellulose, carboxymethylcellulose, or polyvinyl alcohol.

The suspensions or solutions for intramuscular injections may contain, together with the active compound, a pharmaceutically acceptable carrier, e.g. sterile water, olive oil, ethyl oleate, glycols, e.g. propylene glycol,

and, if desired, a suitable amount of lidocaine hydrochloride. The solutions for intravenous injections or infusion may contain as carrier, for example, sterile water or preferably they may be in the form of sterile, aqueous, isotonic saline solutions.

The suppositories may contain together with the active compound a pharmaceutically acceptable carrier, e.g. cocoa butter, polyethylene glycol, a polyoxyethylene sorbitan fatty acid ester surfactant or lecithin.

The following examples illustrate but do not limit the invention.

Example 1

A mixture of 4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxylic acid (0.700g , 3.28 mmol) and carbonyldiimidazol (0.580g , 3.60 mmol) in 10 ml of anhydrous tetrahydrofuran was heated at 40°C for 1.5h. Afterward (1-piperidyl)ethylamine (0.427ml , 4.92mmol) in 5ml of tetrahydrofuran was added, the mixture was heated for additional 2h and stirred at 22°C for 16h. Volatilies were evaporated under reduced pressure and the residue was taken up with water and ethyl acetate; the layers were separated, the organic layer was dried over anhydrous sodium sulphate and evaporated to give 1.0 of raw material, which was partially purified by column chromatography over silica gel

(eluant chloroform/methyl alcohol/ammonia solution 30% 46:4:0.1). The carboxamide was conveniently isolated as its hydrochloride by adding to the free base in acetone/isopropyl alcohol 1 equivalent of hydrochloric acid in isopropyl alcohol. Precipitated solid was filtered, washed with diethyl ether and dried, yielding 746mg (60%) of N-[(1-piperidyl)ethyl]-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxamide hydrochloride hydrate as a colorless solid (m.p. = 237-239°C).

Analogously, the following compounds were prepared :

N-[(1-piperidyl)propyl]-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxamide hydrochloride hydrate (m.p. 192-194°C); and

N-[(1-butyl-piperid-4-yl)methyl]-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxamide hydrochloride (m.p. 260-262°C).

Example 2

A mixture of 4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxylic acid (1.61g , 7.56 mmol) and carbonyldiimidazole (1.35g , 8.32 mmol) in 15 ml of anhydrous tetrahydrofuran was heated at 40°C for 1.5h. Afterward a solution of N-(1-butyl-piperid-4-yl)methyl alcohol (2.59g , 15.1mmol) and 1,8-diazabicyclo[5,4,0]undec-7-en (DBU) (1.13ml , 7.56 mmol) in 10ml of tetrahydrofuran was added and the mixture was heated for additional 2.5h. Volatiles were evaporated

under reduced pressure and the residue was taken up with water and diethyl ether; the layers were separated, the organic layer was dried over anhydrous sodium sulphate and evaporated to give 3.5g of raw material, which was purified
5 by column chromatography over silica gel (eluant chloroform/methyl alcohol 46:4) yielding 1.5g (54%) of (1-butyl-piperid-4-yl)methyl-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxylate (m.p. = 124-126°C) as a colorless solid.

10 Analogously, the following compounds can be prepared :
(1-piperidyl)ethyl-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxylate (m.p. = 152-154°C);
(1-piperidyl)propyl-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxylate; and
15 (S) - (+) - (1-azabicyclo[2,2,2]oct-3-yl)-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxylate.

Example 3

1 equivalent of hydrochloric acid in isopropyl alcohol was added at 5°C to a stirred solution of (1-piperidyl)propyl
20 4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxylate (337mg , 0.996mmol) in acetone . Precipitated solid was filtered, washed with diethyl ether and dried, yielding 342mg (89%) of (1-piperidyl)propyl 4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxylate hydrochloride
25 hemihydrate as a colorless solid (m.p. = 226-228°C).

Analogously, the following compounds were prepared :

(1-piperidyl)ethyl-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxylate hydrochloride hemihydrate (m.p. 255-257°C);

5 (1-butyl-piperid-4-yl)methyl-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxylate hydrochloride (m.p. = 238-240°C); and

(S) - (+) - (1-azabicyclo[2,2,2]oct-3-yl) -4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxylate hydrochloride
10 (m.p. 283.5-284.5); $[\alpha]_D^{23} = +82$ (c = 0.94 , DMF).

Example 4

A mixture of (S) - (+) - [1-azabicyclo[2,2,2]oct-3-yl] -4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxamide (0.508g , 1.58mmol) and n-butylbromide (0.169ml ,
15 1.58mmol) in ethyl alcohol was heated under reflux for 16h. The solvent was removed under reduced pressure, the residue was purified by column chromatography over silica gel (eluent chloroform/ methyl alcohol 4:1) and
crystallized by water giving 0.43g (60%) of (S) - (+) - N-[1-
20 butyl-1-azabicyclo[2,2,2]oct-3-yl] -4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxamide bromide monohydrate as an amorphous colorless solid ; $[\alpha]_D^{23} = +36$ (c = 0.94 , DMF).

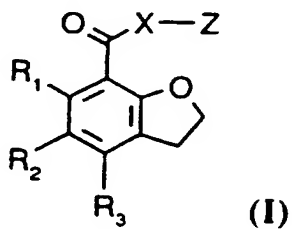
Example 5

With the usual methods of pharmaceutical technique, preparation can be made of capsules having the following composition:

5	N-(1-piperidyl)ethyl-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxamide hydrochloride		
	hydrate		50mg
	talc		2mg
	starch		2mg
10	microcristalline cellulose		6mg
	magnesium stearate		1mg

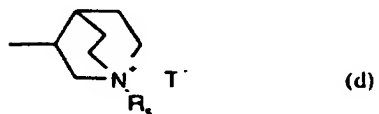
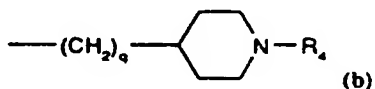
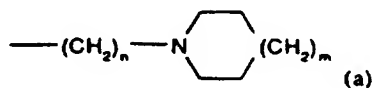
CLAIMS

1. A dihydrobenzofuran derivative of formula (I)



wherein

- R_1 , R_2 and R_3 are, each independently, hydrogen,
 5 C_1 - C_6 alkyl, halogen, hydroxy, C_1 - C_4 alkoxy, amino,
 C_1 - C_4 alkylamino or C_1 - C_4 di-alkylamino;
 X is O, NH or CH_2 ;
 Z is a group (a), (b), (c) or (d)



wherein

n is 1, 2, 3 or 4;

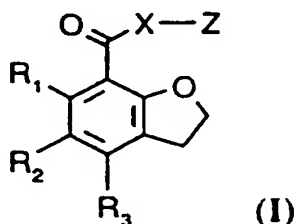
m is zero or 1;

q is zero, 1 or 2;

- 5 R_4 is hydrogen, C_1 - C_6 alkyl, benzyl, cyclohexylmethyl or
- CH_2 - CH_2 - SO_2NH - R_6 in which R_6 is C_1 - C_6 alkyl or benzyl;
 R_5 is C_1 - C_6 alkyl; and
T is halogen;

provided that, when Z is defined under (c), then X is O
10 or CH_2 ; or a pharmaceutically acceptable salt thereof,
for use as a 5-HT₄ receptor agonist.

2. A dihydrobenzofuran derivative of formula (I):



wherein

R_1 is hydrogen;

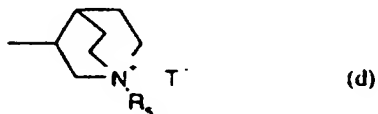
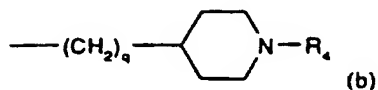
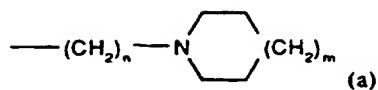
15 R_2 is chlorine or bromine;

R_3 is amino;

X is O or NH;

Z is a group (a), (b), (c) or (d)

26



wherein

n is 2 or 3;

m is zero or 1;

q is 1 or 2;

5 R_4 is C_3 - C_5 alkyl or $-CH_2-CH_2-SO_2NH-CH_3$;

R_5 is C_3 - C_5 alkyl; and

T is chlorine or bromine;

provided that, when Z is defined under (c), then X is O;
or a pharmaceutically acceptable salt thereof.

- 10 3. A compound as claimed in claim 2, selected from:
- N-[1-butyl-1-azabicyclo[2,2,2]oct-3-yl]-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxamide bromide;
- (1-azabicyclo[2,2,2]oct-3-yl)-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxylate;
- 15 (1-butyl-piperid-4-yl)methyl-4-amino-5-chloro-2,3-dihydrobenzo[b]furan-7-carboxylate;
- (1-piperidyl)propyl-4-amino-5-chloro-2,3-dihydrobenzo

[b] furan-7-carboxylate;
(1-piperidyl)ethyl-4-amino-5-chloro-2,3-dihydrobenzo
[b] furan-7-carboxylate;
N-[(1-butyl-piperid-4-yl)methyl]-4-amino-5-chloro-2,3-
5 dihydrobenzo[b]furan-7-carboxamide;
N-[(1-piperidyl)propyl]-4-amino-5-chloro-2,3-
dihydrobenzo[b]furan-7-carboxamide; and
N-[(1-piperidyl)ethyl]-4-amino-5-chloro-2,3-
dihydrobenzo[b]furan-7-carboxamide;
10 if the case either as a single isomer or as a mixture of
isomers, and the pharmaceutically acceptable salts
thereof.

4. A compound as claimed in claim 2 or 3 for use as a
5HT₄ receptor agonist.

15 5. A compound as claimed in claim 1,2 OR 3 for use as a
5-HT₄ receptor agonist in the treatment of a pathology
wherein stimulation of a 5-HT₄ receptor is needed.

6. A compound as claimed in claim 1, 2 or 3 for use as
a therapeutic prokinetic agent in the treatment of
20 gastrointestinal disorders.

7. A compound as claimed in claim 6 wherein the

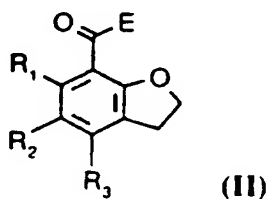
gastrointestinal disorder is dyspepsia, gastro-oesophageal reflux disease (GORD) or gastroparesis.

8. A compound as claimed in claim 1, 2 or 3 for use as a cognition activator in the treatment of CNS disorders characterized by learning and/or memory dysfunctions.

9. Use of a compound as defined in claim 1, 2, or 3 in the preparation of a medicament for use as a 5HT₄ receptor agonist.

10. A process for preparing a dihydrobenzofuran derivative of formula (I) as defined in claim 1 or 2, or a pharmaceutically acceptable salt thereof, said process comprising:

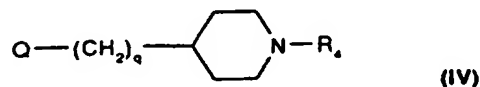
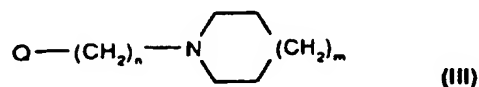
A) reacting of a compound of formula (II)



wherein

15 E is OH, Cl, Br or 1-imidazolyl, and
R₁, R₂ and R₃ are, each independently, hydrogen, C₁-C₆ alkyl, halogen, hydroxy, C₁-C₄ alkoxy, amino,

C₁-C₄ alkylamino or C₁-C₄ di-alkylamino,
with an amine or an alcohol of formula (III), (IV) or (V)



wherein

Q is OH or NH₂;

5 n is 1, 2, 3 or 4;

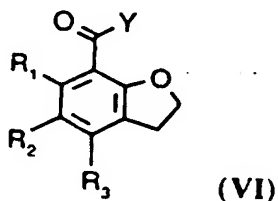
m is 0 or 1;

q is 0, 1 or 2; and

R₄ is hydrogen, C₁-C₆ alkyl, benzyl, cyclohexylmethyl or
-CH₂-CH₂-SO₂NH-R₆ in which R₆ is C₁-C₆ alkyl or benzyl,

10 so obtaining a compound of formula (I) wherein R₁, R₂, R₃
and R₆ are as defined above, X is NH or O and Z is a
group (a), (b) or (c); or

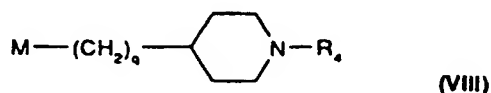
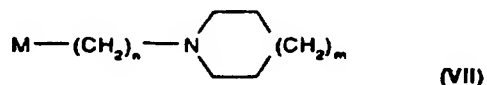
B) reacting a compound of formula (VI)



wherein

15 Y is OH, Cl, Br or CH₃-NH-OCH₃, and

R_1 , R_2 and R_3 are as defined above,
with an organometallic derivative of formula (VII),
(VIII) or (IX)



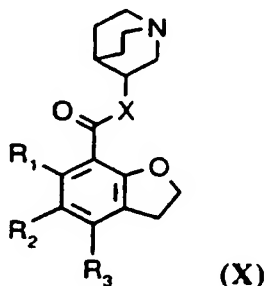
wherein

5 M is MgBr, MgCl or Li, and

n , m , q , R_4 and R_5 are as defined above,

so obtaining a compound of formula (I) wherein R_1 , R_2 and
 R_3 are as defined above, X is CH_2 and Z is a group (a),
(b) or (c); or

10 C) reacting a compound of formula (X)



wherein

R_1 , R_2 , R_3 and X are as defined above, and

X is NH, O or CH_2 ,

with an alkyl halide of formula R_5T wherein R_5 is

C₁-C₆ alkyl and T is halogen, so obtaining a compound of formula (I) wherein R₁, R₂, and R₃ are as defined above, X is O, NH or CH₂ and Z is a group (d); and, if desired, when a compound of formula (I) contains an asymmetric carbon atom,

D) resolving the racemic mixture of a compound of formula (I) into the single isomers; and/or, if desired, E) converting a compound of formula (I) into a pharmaceutically acceptable salt thereof.

10 11. A pharmaceutical composition comprising a carrier and/or a pharmaceutically acceptable diluent and, as an active substance, a compound as defined in claim 1, 2 or 3.

12. A pharmaceutical composition according to claim 11, 15 for use in the treatment of a pathology wherein stimulation of a 5HT₄ receptor is needed.

13. A pharmaceutical composition according to claim 11, for use as a therapeutic prokinetic agent in the treatment of gastrointestinal disorders.

20 14. A pharmaceutical composition according to claim 13 wherein the gastrointestinal disorder is dyspepsia,

gastro-oesophageal reflux disease (GORD) or
gastroparesis.

15. A pharmaceutical composition according to claim 11
for use as a cognition activator in the treatment of CNS
5 disorders characterized by learning and/or memory
dysfunctions.

INTERNATIONAL SEARCH REPORT

Intern. Application No.
PCT/E 6/01482

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 C07D307/79 C07D405/12 A61K31/445 C07D453/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 C07D A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

22 July 1996

Date of mailing of the international search report

14.08.96

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Scruton-Evans, I

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/EP 96/01482

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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X	WO,A,94 26314 (C JOHN) 24 November 1994 see example 2 and claims 1 and 40 ---	1,5-8, 10-15
Y	US,A,5 122 528 (A IMONDI) 16 June 1992 see whole document, especially the compounds of column 16 ---	1-15
X	EP,A,0 445 862 (JANSSEN PHARMACEUTICA) 11 September 1991 see general formula I ---	1,5-8, 10-15
X	PATENT ABSTRACTS OF JAPAN vol. 13, no. 326 (C-620), 24 July 1989 & JP,A,01 104072 (YOSHITOMI PHARMACEUTICAL INDUSTRY LTD), 21 April 1989, see definitions of X and R4 see abstract ---	1,5-8, 10-15
X	WO,A,93 16072 (SMITHKLINE BEECHAM PLC) 19 August 1993 cited in the application see whole document, especially example 2 ---	1,5-8, 10-15
Y	BIOORGANIC AND MEDICINAL CHEMISTRY LETTERS, vol. 3, no. 4, 1993, pages 633-634, XP000576640 G.S.BAXTER ET AL: "Quaternised Renzapride as a potent and selective 5-HT4 receptor agonist" see the whole document -----	1-15

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Information on patent family members

Intern Application No

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No.

PCT/EP 96/01482

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